

**A new species of crayfish of the genus *Procambarus*, subgenus *Ortmannicus* (Decapoda: Cambaridae), from the Waccamaw River basin, North and South Carolina**

John E. Cooper

North Carolina State Museum of Natural Sciences, P. O. Box 29555,  
Raleigh, North Carolina 27626, U.S.A.

*Abstract.*—*Procambarus (Ortmannicus) braswelli* is a new species of crayfish from the Waccamaw River basin in North and South Carolina. A primitive member of the Pictus Group, *P. braswelli* has its closest affinities with *P. (O.) chacei*, *P. (O.) enoplosternum*, and *P. (O.) pictus*. The new species is less closely related to *P. (O.) epicyrtus*, and distantly related to its geographically nearest relative, *P. (O.) lepidodactylus*, with which it has been confounded. The occurrence of *P. lepidodactylus* in North Carolina is currently unconfirmed. *Procambarus braswelli* may be distinguished from the other members of the Pictus Group by its combination on the form I male gonopod (first pleopod) of a prominent, truncated, distally directed caudal knob; a large, somewhat bulbous adventitious process; and a long, caudodistally directed mesial process; and by a long acumen.

The Waccamaw River basin of southeastern North Carolina and northeastern South Carolina has long been known as home to a number of animal species that are either endemic or are shared with a single other river basin. The endemic fauna includes several fishes and mollusks. Information on the fishes can be found in Hubbs & Raney (1946), Frey (1951), Shute et al. (1981), Menhinick (1991), and Rohde et al. (1994). The mollusks are discussed in Fuller (1977), Johnson (1984), and Porter & Horn (1984). Teulings & Cooper (1977: 414-415) provided a list of the endemic species.

Included in the Waccamaw invertebrate fauna is a crayfish previously assigned to *Procambarus (Ortmannicus) lepidodactylus* Hobbs, 1947a, a species considered the northernmost representative of the primitive Pictus Group (Hobbs 1958a, 1962, 1968, 1972, 1974, 1989; Cooper & Cooper 1977a, 1977b). Few specimens of this Waccamaw crayfish have been collected, and the only published locality was "canal off Wacca-

maw River, apparently 7.5 air mi. [12.0 air km] south of Lake Waccamaw, Columbus County (1949)" (Cooper & Cooper 1977b: 206). This record was based on a female in the collections of the National Museum of Natural History, Smithsonian Institution (USNM 129841), collected on 29 March 1949 by E. C. Raney. It is the only North Carolina specimen identified as *P. lepidodactylus* in the catalogued collections of that institution, and the locality is obviously the same one referred to as "Columbus County" by Hobbs (1968:K9, 1972:61, 1974:57, 1989:68). None of the North Carolina specimens later assigned to *P. lepidodactylus* had received critical examination. Prompted by a form I male collected by David R. Lenat, North Carolina Division of Water Quality, I determined that these specimens represent an undescribed species of the Pictus Group that appears to be endemic to the Waccamaw River basin and that is only distantly related to *P. lepidodactylus*. This new species is currently known only from Columbus County, North

Carolina, and from a single locality in Horry County, South Carolina, but it may be found elsewhere within the Waccamaw basin.

Because *P. lepidodactylus* (s.s.) occurs in the Pee Dee River basin in South Carolina, Cooper & Cooper (1977b:207) speculated that it "may yet be discovered in tributaries of the Lumber River of North Carolina . . ." A distribution map showing localities for members of the Pictus Group (Hobbs 1958a:72) contains a single North Carolina site for "*P. lepidodactylus*." The site indicated by a dot in the map lies just west of the 79th meridian, which would place the locality in the Lumber River basin. However, the dot undoubtedly was meant to represent the Columbus County record in the Waccamaw basin (USNM 129841). I know of no specimens of *Procambarus* from North Carolina that incontrovertibly can be assigned to *P. lepidodactylus*. Several specimens that could belong to this species have been collected in the Lumber basin (Cooper & Braswell 1995:120), but form I males have yet to be seen.

Abbreviations used in the text are: j = juvenile; NC = North Carolina state highway; NCSM = North Carolina State Museum of Natural Sciences, Raleigh; PCL = postorbital carapace length; R = river; SR = state secondary road; TCL = total carapace length; UNC = University of North Carolina; USGS = United States Geological Survey; US = United States highway; USNM = United States National Museum of Natural History, Smithsonian Institution, Washington, D. C.; and UTM = Universal Transverse Mercator coordinates.

*Procambarus (Ortmannicus) braswelli*,  
new species

Fig. 1

*Procambarus lepidodactylus*.—Hobbs, 1958a:72 (p.p.; map locality for North Carolina), 75, 76 (p.p.; southeastern North Carolina).—Hobbs, 1962:284 (p.p.; southeastern North Carolina).—

Hobbs, 1968:K9 (p.p.; Columbus County, North Carolina).—Hobbs, 1972:151 (p.p., North Carolina).—Franz & Lee, 1982:61 (p.p.; North Carolina).—LeGrand & Hall, 1997:32 (p.p.; Waccamaw drainage, North Carolina).

*Procambarus (Ortmannicus) lepidodactylus*.—Cooper & Cooper, 1977a:198, 1977b:206, 207 (p.p.; North Carolina).—Cooper & Cooper, 1977a:200 (p.p.; by implication, North Carolina).—Hobbs, 1972:61, 1974:57, 1989:68 (p.p.; Columbus County, North Carolina).—Hobbs & Peters, 1977:8 (p.p.; North Carolina).—Hobbs et al., 1977:19 (p.p.; North Carolina).—Teulings & Cooper, 1977:415 (p.p.; North Carolina).—Fitzpatrick, 1983:214 (p.p.; Carolinas, viz. North Carolina).—Hobbs & Franz, 1986:516 (p.p.; North Carolina).—Hobbs, 1989:86 (p.p.; North Carolina).

*Procambarus leptodactylus*.—Williams et al., 1989:26, 64 (p.p.; by implication, North Carolina; erroneous spelling).—LeGrand, 1993:23, LeGrand & Hall, 1995:31 (p.p.; Waccamaw drainage, North Carolina; erroneous spelling). "Undescribed species."—Cooper & Braswell, 1995:120.

*Diagnosis*.—Body and eyes pigmented, eyes large ( $\bar{X}$  adult diam 2.4 mm,  $n = 11$ ). Rostrum acarinate, margins narrow, parallel to subparallel near base, slightly convex between orbits, then recurving and tapering to base of long acumen, which delineated by strong marginal spines; acumen comprising 41.9 to 49.1% ( $\bar{X} = 44.8\%$ ,  $n = 12$ ) of rostrum length, latter comprising 31.7 to 37.9% ( $\bar{X} = 34.4\%$ ) of TCL. Areola 2.1 to 4.2 ( $\bar{X} = 2.9$ ,  $n = 13$ ) times as long as broad and constituting 26.3 to 28.2% ( $\bar{X} = 26.9\%$ ,  $n = 12$ ) of TCL and 39.4 to 42.8% ( $\bar{X} = 41.3\%$ ,  $n = 13$ ) of PCL, and with 6 to 9 (usually 7–8) punctations across narrowest part. Carapace densely granulate, cephalic section constituting 71.8 to 74.8% ( $\bar{X} = 73.1\%$ ,  $n = 12$ ) of TCL. Cervical spines strong, 1 each side; cervical groove inter-

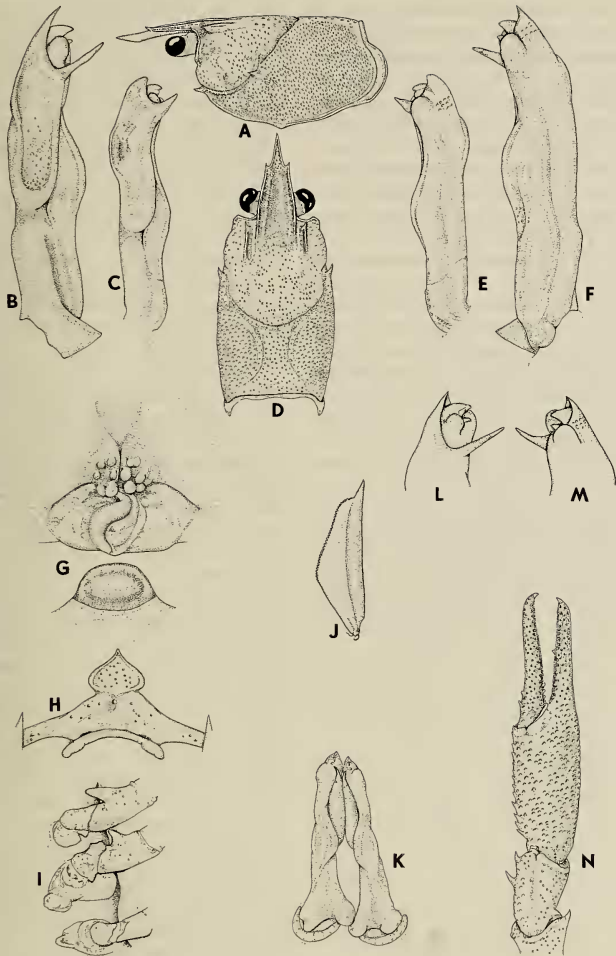


Fig. 1. *Procambarus (Ortmannicus) braswelli*, new species (all from holotypic male, form I, except C, E, from morphotypic male, form II, and G, from allotypic female; setae not illustrated): A, lateral aspect of cephalothorax; B, C, mesial aspect of left gonopod (first pleopod); D, dorsal aspect of cephalothorax; E, F, lateral aspect of left gonopod; G, annulus ventralis and associated structures; H, epistome; I, basal podomeres of third, fourth, and fifth pereiopods; J, antennal scale; K, caudal aspect of in situ gonopods; L, M, caudomesial and caudolateral aspects, respectively, of tip of left gonopod; N, dorsal aspect of distal podomeres of right cheliped.

rupted. Branchiostegal spine strong; hepatic area with some weak tubercles. Suborbital angle obtuse to obsolete. Postorbital ridge moderately strong, with nearly obliterated groove and strong cephalic spine. Antennal scale 2.9 to 3.4 ( $\bar{X} = 3.2$ ,  $n = 13$ ) times as long as broad, widest proximal to mid-length; lateral margin thickened and terminating in acute spine, mesial (lamellar) margin subangular.

Palm of chela of cheliped 1.1 to 1.7 ( $\bar{X} = 1.4$ ,  $n = 13$ ) times wider than deep, 1.3 to 1.8 ( $\bar{X} = 1.6$ ,  $n = 13$ ) times longer than wide, and constituting 40.2 to 46.7% ( $\bar{X} = 42.5\%$ ,  $n = 12$ ) of chela length; mesial margin of palm with staggered row of 5 to 13 small, subconical tubercles. Fingers without gape, without dense setae at opposable bases; dactyl 1.1 to 1.4 ( $\bar{X} = 1.2$ ,  $n = 13$ ) times length of mesial margin of palm.

Hooks on ischia of third and fourth pereopods of male; in form I male (Fig. 11), hook on third pereopod oblique, subconical, overreaching basioischial articulation by most of length, not opposed by tubercle on basis; hook on fourth pereopod smaller, vertically disposed, not reaching articulation, and opposed by prominent protuberance on basis, center of protuberance with curved, setiferous depression; coxa of fourth pereopod with low, vertically disposed caudomesial boss, that of fifth pereopod with compressed ridgelike boss at caudomesial angle (Fig. 11).

Gonopods (first pleopods) of form I male (Fig. 1B, F, K, L, M) asymmetrical, proximomesial apophyses strong, tapering, generally rounded but with subacute tip caudally, overlapping; total length of gonopod 22.1 to 25.6% ( $\bar{X} = 23.8\%$ ,  $n = 4$ ) of TCL; distal  $\frac{1}{4}$  of shaft weakly inclined caudodistally, cephalic surface with narrow convexity subjacent to base of cephalic process; mesial process long, slender, noncorneous, directed caudodistally and inclined laterally, tip acute to subtruncate; central projection and cephalic process corneous, subequal in length; cephalic process with acute apex, directed distally and slightly

caudally, and with expanded base forming cowl around cephalic base of central projection; latter subtriangular, directed caudodistally at much greater angle than cephalic process; caudal element consisting of: prominent distolateral caudal knob, directed distally and delimited cephalically by groove; small, toothlike caudal process, originating on mesial surface of central projection and directed caudodistally; and inflated adventitious process, originating at proximomesial base of cephalic process, lying wholly mesial or cephalomesial to caudal process, and obscuring part of proximomesial bases of central projection and caudal process.

Annulus ventralis (Fig. 1G) symmetrical, subovate, 2.4 times as wide as long, movable; cephalic margin broadly arched, caudal margin mildly convex and with weak caudomedian labiellum; median  $\frac{1}{2}$  of annulus ventrally elevated, moundlike; dextral half of mound hemitubular, C-shaped, sinistral half slightly narrower, following contours of dextral half; both parts of central mound descending cephalically as pair of short, narrow, curved ridges, which tapering cephalically and terminating sinistral to midline of cephalic margin of annulus; narrow, somewhat C-shaped ridge dextralateral to central mound at about midlength of annulus, and short horizontal ridge sinistrolateral to mound at same level; deep subtriangular depression cephalolateral to central mound on either side of curved ridges, each depression with prominent protuberance near cephalolateral margin.

Measurements of type specimens provided in Table 1.

*Description of holotypic male, form I.*—Body and eyes pigmented, eye 2.9 mm diam. Cephalothorax (Fig. 1A, D) subcylindrical; maximum width of carapace 1.1 times depth, cephalic section 2.8 times length of areola and constituting 73.4% of TCL. Areola 3.3 times as long as wide, constituting 26.6% of TCL (39.5% of PCL), densely punctate, with 7 to 8 punctations across narrowest part; branchiocardiac

Table 1.—Measurements (mm) of types of *Procambarus (Ortmannicus) braswelli*, new species.

	Holotype	Allotype	Morpho- type
Carapace			
Total length	27.4	29.6*	20.2
Postorbital length	18.5	19.4	13.8
Length cephalic section	20.1	21.3*	14.5
Width	11.8	13.5	9.0
Depth	10.4	12.4	9.1
Rostrum			
Length	9.0	9.7*	6.4
Width at base	4.0	4.6	3.4
Length acumen	3.8	off	2.7
Areola			
Length	7.3	8.3	5.7
Width	2.2	2.0	2.1
Antennal scale			
Length	9.1	9.8	7.4
Width	2.7	3.4	2.3
Abdomen			
Length	28.3	34.6	22.0
Width	10.5	12.9	7.3
Cheliped			
Length lateral margin chela	19.8	15.9	10.5
Length mesial margin palm	8.6	6.6	4.9
Width palm	5.2	5.2	2.7
Depth palm	3.9	3.0	2.0
Length dactyl	9.5	8.3	5.5
Length carpus	6.4	6.2	4.1
Width carpus	3.9	4.1	2.3
Length dorsal margin merus	10.6	9.9	6.8
Depth merus	3.7	4.1	1.9
Gonopod length	6.2	NA	4.8

\* estimated; acumen damaged.

grooves strong, flaring caudolaterally from about midlength. Rostrum with narrow, elevated margins, extending caudally nearly to caudal margin of postorbital ridges; margins of rostrum parallel near base, slightly convex between orbits, then recurving and converging to base of long, spiculiform acumen which delineated by strong marginal spines; rostrum deeply excavate, margins flanked medially by continuous row of setiferous punctations; walls of rostrum slop-

ing, floor (dorsal surface) slightly concave, punctations most abundant in cephalic half; acumen comprising 42.2% of rostrum length, apex corneous, directed cephalically and extending to distal margin of second article of antennular flagellum; ventral keel of acumen bladelike, broadly subangular in lateral aspect; subrostral ridge visible in dorsal aspect only at base of rostrum. Postorbital ridge moderately strong, with thin dorsal crest and narrow, nearly obliterated lateral groove bearing small punctations; cephalic margin with strong spine. Suborbital angle obsolete, orbital rim subrectilinear and with concavity near base of antennal peduncle. Cervical spines strong, 1 each side, and area also with dense granulations dorsal to spine; cervical groove interrupted just dorsal to spine, with short, broad sulcus cephalic to groove; ventral margin of cephalic portion of groove with row of small tubercles. Carapace with thoracic section densely granulate laterally and dorsally, granules ascending to margins of branchiocardiac grooves; cephalic section of carapace with scattered granules laterally; caudal mandibular region broadly convex, delimited by moderate groove; gastric region with crowded punctations, caudal margin of region in form of low, arcuate ridge.

Branchiostegal spine long, slightly procurved. Antennal peduncle with long distolateral spine on basis and similar spine on ventral surface of ischium; antennular peduncle with strong, semierect ventral spine situated near mesial margin at about midlength of basal podomere, which hirsute mesially and with sparse setae ventrally; tip of antennal flagellum reaching cephalic margin of telson when flagellum adpressed. Antennal scale (Fig. 1J) 3.4 times as long as wide, broadest proximal to midlength; lateral margin thickened and terminating in strong distal spine, tip reaching slightly beyond proximal margin of third article of antennular flagellum; lamella approximately twice as wide as thickened lateral portion, distal margin slightly sloping for short dis-



tance then strongly declivous to widest part; mesial margin subangular.

Abdomen slightly longer and narrower than carapace; pleura of most abdominal segments with rounded cephalolateral margins, and slightly rounded to subangular caudoventral margins. Proximal podomere of right uropod (left uropod regenerate, deformed) with very strong caudolateral spine on lateral lobe, and slightly weaker, somewhat laterally situated spine on mesial lobe; mesial ramus of uropod with long caudolateral spine, and strong median ridge terminating in spine situated well cephalic to caudal margin; lateral ramus with broad median ridge on cephalic section, and poorly defined ridge lateral to it; transverse flexure of ramus with margin bearing row of 11 fixed spines, and large movable spine, with small spine at dorsal base, near lateral margin of ramus. Telson with 3 spines in each caudolateral corner of cephalic section, middle one movable, mesial one on left bifurcate; transverse suture strong; caudal margin of telson truncate and with slight median concavity. Uropods and telson with few setae dorsally.

Epistome (Fig. 1H) with subtriangular cephalic lobe bearing long, triangular cephalomedian projection; lobe strongly constricted at base, transverse sulcus indistinct; margins of lobe slightly thickened, elevated (ventrally), somewhat undulant, incomplete at base of projection, and with long, dense setae; lateral apices thicker than rest of margin, rounded, somewhat flared; floor (ventral surface) of lobe slightly convex, very punctate, setiferous; body of epistome with broad central depression bearing shallow cephalomedian fovea; lamellae punctate, tapering laterally to subtruncate margin devoid of tubercles; zygoma moderately arched, flanked cephalolaterally by usual elongate pits.

Third maxilliped with tip of endopodite of ischium extending nearly to distal margin of penultimate podomere of antennal peduncle, tip of exopodite extending to just beyond distal margin of merus of endopod-

ite; basal podomere of exopodite not hirsute; ventrolateral margin of ischium with row of setiferous punctations at base of longitudinal ridge, distolateral corner produced as acute spine; ventrolateral half of ischium with scattered punctations bearing short setae; ventromesial half with longitudinal rows of long setae, moderately obscuring mesial margin; basis of ischium with clumps of long setae, forming brushes. Right mandible with incisor ridge bearing 8 denticles, third from distal end largest, penultimate one small, left incisor ridge with 6 denticles, distalmost largest.

Palm of chela of cheliped (Fig. 1N) subovate in cross section, 1.3 times wider than deep, 1.7 times longer than wide; mesial margin of right palm with mesial row of 11 subconical tubercles (9 on left) of varying sizes, most with distal margin elevated; other obvious tubercles dorsal and ventral to mesial row; distal margin of mesial surface developed as 12th (10th on left) tubercle, with large spiniform tubercle and smaller rounded tubercle proximoventral to it; dorsal, mesial, and lateral surfaces of palm crowded with strong squamous tubercles of varying sizes, and recumbent setae; ventral surface of palm less densely tuberculate, many tubercles subspiniform; articular ridge of palm, dorsally and ventrally, poorly defined, lateral eminence especially weak; lateral eminence ventrally with very strong subdistal spine. Fingers narrow, with opposable surfaces contiguous and lacking prominent setae at bases; fingers slightly curved distoventrally in lateral aspect, dorsal surfaces studded with punctations and tufts of stiff setae. Right dactyl 48.0% of chela length, 1.1 times as long as palm; dorsal surface of dactyl with narrow, weak longitudinal ridge, ventral surface rounded and without ridge; proximal  $\frac{1}{3}$  of ventral surface with 5 or 6 small tubercles; mesial margin of dactyl with 2 (4 on left) large, semierect tubercles in row near base, and several smaller tubercles dorsal and ventral to them, rest of margin punctate; opposable margin with dense pad of denticles in 6 to

7 rows throughout length of dactyl, pad narrower near base; proximal half of finger with 8 to 9 (5 on left) small tubercles dorsal to denticles, basal 2 largest; ventral to denticles, surface with 1 small, subacute tubercle near base and 2 large contiguous tubercles situated at base of distal  $\frac{3}{4}$  of finger, interrupting denticles (on left, single large tubercle at this site). Fixed finger with narrow longitudinal ridge dorsally, and moderate ridge ventrally; lateral surface of finger rounded, with rows of deep punctations and clumps of stiff setae; opposable margin with dense pad of denticles in 7 to 8 rows throughout length of finger, pad narrower near base; large subconical tubercle ventral to denticles just distal to midlength; proximal  $\frac{1}{3}$  of finger with 5 (4 on left) small, rounded tubercles dorsal to denticles, third from base largest.

Carpus of cheliped (Fig. 1N) 1.6 times as long as wide, length 74.4% of palm length; dorsal surface with very shallow, slightly oblique sulcus, surface lateral to which punctate, mesial to which with 2 to 3 rows of subconical tubercles extending onto dorsomesial surface; large spine mesial to dorsal articular eminence; ventral surface with very strong distolateral spine, strong distal spine mesial to distolateral one, smaller spine just proximal to distomedian one, 2 small acute tubercles proximal to both of the latter, and 2 weak spines and 4 tubercles near mesial margin; latter with strong, curved subdistal spine and 4 to 5 proximal tubercles. Merus of cheliped 2.9 times longer than deep, depth fairly uniform throughout length, latter 38.3% of TCL; dorsal surface with 2 strong, contiguous subdistal spines, and row of spiniform tubercles along dorsomedian ridge; dorsal spines and tubercles flanked mesially and laterally by other spiniform to squamous tubercles; distal half of mesial surface tuberculate, lateral surface punctate and with some minute, scattered tubercles; ventrolateral ridge with large distal spine near articular eminence, 3 other strong spines; 8 to 9 small tubercles, and row of small tubercles

between distal extremity of ridge and large distal spine; ventromesial ridge with large distal spine, patch of 3 large spines just proximal to distal spine, and 11 or 12 spiniform tubercles; other obvious tubercles on dorsomesial surface, and patch of 5 to 6 tubercles between distal extremities of both ridges; ventral surface of merus between ridges with some small tubercles and dense setae. Ischium with row of 4 (5 on left) subspiniform tubercles on ventral ridge; sufflamen obsolete on right, short on left. Merus of second through fourth pereiopods with prominent distolateral spine.

Hooks on ischia of third and fourth pereiopods simple (Fig. 1I), that on third long, subconical, slightly curved and overreaching basioischial articulation by most of length, not opposed by tubercle on basis; hook on fourth pereiopod short, vertically disposed, not reaching articulation, and as in "Diagnosis." Coxae of fourth and fifth pereiopods also as in "Diagnosis." Sternites between third and fourth pereiopods with long setae.

For description of gonopod see "Diagnosis." In addition, intact subapical setae (not illustrated) flanking mesial, cephalic, and lateral bases of cephalic process and central projection, largely obscuring both elements.

*Description of allotypic female.*—Differing from holotypic male, except in secondary sexual characters, as follows: Areola 4.2 times as long as broad, constituting approximately 28.0% of TCL (acumen damaged) and 42.8% of PCL, with 6 punctations across narrowest part. Cervical area with 2 tubercles ventral to cervical spine. Cephalolateral corners of cephalic section of telson with 4 spines on left, 3 on right. Antennal scale 2.9 times as long as broad. Chela of cheliped 1.7 times wider than deep; mesial margin of palm with mesial row of 5 to 6 tubercles. Longitudinal ridges on fingers of cheliped well developed. Mesial surface of dactyl with single prominent tubercle and other squamous to subsquamous tubercles near base; opposable sur-

face with 4 rounded tubercles on proximal  $\frac{1}{2}$  to  $\frac{1}{4}$ , and several smaller tubercles distally; denticles in single row; opposable margin of fixed finger with row of 6 tubercles, denticles in single row. Carpus of cheliped 1.5 times as long as wide, length 93.9% of length of mesial margin of palm; merus 2.4 times as long as deep, length 33.4% of TCL; ventrolateral ridge with row of 7 spines or spiniform tubercles in addition to distal spine, ventromesial ridge with 13 spines or tubercles and large distal spine.

For description of annulus ventralis (Fig. 1G) see "Diagnosis." In addition, postannular sclerite nearly twice as wide as long, about half as wide as annulus. Preannular sternite with broadly flared walls, deep median cleft in caudal half, and 5 to 6 protuberant lobes on either side of cleft, caudalmost pair overhanging cephalic margin of annulus. First pleopods uniramous, extending just beyond caudal margin of preannular sternite when abdomen flexed.

*Description of morphotypic male, form II.*—Differing from holotypic male in following respects: Areola 2.7 times as long as broad, constituting 28.2% of TCL (41.3% of PCL), sparsely punctate; apex of acumen reaching to proximal base of first article of antennular flagellum. Antennular scale 3.2 times as long as wide. Mesial margin of palm of cheliped with mesial row of 8 tubercles; lateral eminence of ventral articular ridge with small tubercle. Mesial margin of dactyl with 3 tubercles; opposable margin with 3 minuscule tubercles ventral to denticles in proximal  $\frac{1}{4}$  of finger, and 2 small tubercles dorsal to denticles near base of finger; denticles in single row. Opposable margin of fixed finger with 3 or 4 small tubercles, denticles in 2 to 3 rows. Carpus of cheliped 1.8 times as long as broad, length 83.7% of length of mesial margin of palm; merus 3.4 times as long as deep, length 33.7% of TCL; ventrolateral ridge with 2 strong spines in addition to large distal spine, ventromesial ridge with 11 small tubercles and large (broken) distal spine; ischium with 5 (4 on left) minuscule

tubercles. Hooks on ischia of third and fourth pereopods reduced; boss on coxa of fourth pereopod not pronounced, that on fifth pereopod narrow.

Gonopods (Fig. 1C, E) with proximomesial apophyses separated; mesial process stout, tapering, tip directed caudally; gonopod in lateral aspect with "juvenile suture"; cephalic convexity apparent; all terminal elements blunter and thicker than in form I male, not corneous, all except caudal process identifiable and relationships clearly visible; subapical setae sparse; gonopod in mesial aspect with poorly defined caudal process, and adventitious process reduced to narrow ridge.

*Disposition of types.*—The holotypic male, allotypic female, and morphotypic male are in the crustacean collections of the NCSM (catalogue numbers NCSM C-2507, C-2549, and C-2550, respectively), as are paratypes consisting of 3 ♂ I, 3 j ♂, 3 ♀, 3 j ♀.

*Type locality.*—North Carolina, Columbus County, Waccamaw River at NC 130 near Brunswick County line, 8.0 air km (5.6 air mi) SSE of Old Dock (Freeland USGS 7.5' quadrangle, UTM coordinates 3775210N/726190E).

*Range and specimens examined.*—Known only from the Waccamaw River basin in North and South Carolina, where the following collections have been made: North Carolina. Columbus Co.—Waccamaw R at NC 130 (type locality); 1 ♂ I (NCSM C-2507), 17 Jun 1991, 1 ♀ (NCSM C-2234), ? Aug 1984, coll. D. R. Lenat; Waccamaw R at Lake Waccamaw dam, S end of SR 1967, ca. 7.4 air km S of town Lake Waccamaw; 1 ♂ I, 1 j ♂, 1 j ♀ (NCSM C-316), 1 ♀ (NCSM C-2549), 22 Oct 1978, coll. A. L. Braswell, R. E. Ashton, Jr., P. S. Ashton; Waccamaw R between spillway & SR 1928; 1 ♂ I, 1 ♀, 2 j ♀ (NCSM C-2066), 29 Mar 1978, coll. W. S. Birkhead; Waccamaw R below Bogue Swamp, "near dam" at Lake Waccamaw; 1 j ♂, 1 j ♀ (NCSM C-2515), 19 Jun 1991, coll. D. R. Lenat, F. Winborne, L. Eaton;



Waccamaw R, N of NC 130 (probably 2.8 river km N); 1 ♂ I (NCSM C-963), 1 ♂ II (NCSM C-2550), 22 Apr 1979, coll. UNC-Wilmington biologists; canal off Waccamaw R, 1.6 km N of river, apparently 12.0 air km S of Lake Waccamaw; 1 ♀ (USNM 129841), 29 Mar 1949, coll. E. C. Raney. South Carolina. Horry Co.—Smith Lake at end of Park Ave, northern Conway; 1 j ♂ (NCSM C-3247), 10 May 1994, coll. R. G. Arndt & students.

*Variations.*—Significant variations are addressed in the "Diagnosis," but others are also evident. The tubercle on the lateral eminence of the ventral articular ridge of the palm of the chela varies from large and spiniform to small and subsquamous, and is absent in one small female. The tubercles in the mesial row of the mesial margin of the palm range in number from five to thirteen, and in size from barely discernible to large and obvious; in the four form I males they number from ten to thirteen and are conspicuous, while in females they number from five to nine and generally are inconspicuous. The number of tubercles on the opposable margin of the fixed finger, exclusive of the prominent subconical one, varies from one to six, but the usual number is two or three. The number of tubercles on the opposable margin of the dactyl ranges from two to thirteen, but usually is two to five. In most specimens these tubercles are very small, and in several they are scarcely discernible. Some are dorsal to the denticles, but others are either ventral to them or interrupt them ventrally. The tubercles along the dorsomedian ridge of the merus vary in size and configuration, from barely visible, squamous tubercles to small spines. In all specimens there is a single cervical spine on each side of the carapace, but the allotype also has two tubercles ventral to the spine. There almost always are three spines in each caudolateral corner of the cephalic section of the telson, but five specimens have four spines in one corner, three in the other.

In form I males the opposable surfaces

of both fingers of the chela are densely packed with denticles, arranged in five to nine somewhat irregular rows. Females and juvenile males have a single row of denticles on these surfaces, and the morphotypic male has two to three rows on the fixed finger and a single row on the dactyl.

*Size.*—The largest specimen, a female with a damaged acumen, has an estimated TCL of 29.6 mm (PCL 19.4 mm). Four other females range from 18.5 to 25.5 mm TCL (12.0–16.7 mm PCL). The four form I males range from 19.5 to 27.4 mm TCL (12.8–18.5 mm PCL).

*Life history notes.*—Form I males have been found in March, April, June, and October. No ovigerous females or those with attached young have been collected.

*Crayfish associates.*—Cooper & Braswell (1995:120–121) briefly discussed the crayfishes of the Waccamaw River basin. The only species that have been taken with *P. braswelli* are *Procamburus (Ortmannicus) acutus* (Girard, 1852), *Procamburus (Ortmannicus) ancylus* Hobbs, 1958b, and *Procamburus (Ortmannicus) blandingii* (Harlan 1830).

*Relationships.*—Based on the configuration of the form I male gonopod, *P. braswelli* has its closest affinities with *Procamburus (Ortmannicus) chacei* Hobbs, 1958c, *Procamburus (Ortmannicus) enoplosternum* Hobbs, 1947b, and *Procamburus (Ortmannicus) pictus* (Hobbs 1940), is somewhat more distantly related to *Procamburus (Ortmannicus) epicyrtus* Hobbs, 1958c, and is even more distantly related to its geographically nearest neighbor, *P. lepidodactylus*.

*Procamburus braswelli* may be distinguished from all other members of the Pictus Group by the combination of: a gonopod whose distal one-fourth is only slightly caudally directed; a small but obvious cephalic convexity; an almost distally directed cephalic process whose caudal base is transversely expanded and forms a cowl or hood around the cephalic base of the slightly longer, caudodistally directed central projec-

tion; a long mesial process that is caudo-distally directed at about 45° to the shaft of the gonopod; a prominent, distally directed caudal knob that extends only slightly beyond the proximocaudal bases of the cephalic process and central projection; a large adventitious process that in mesial aspect obscures part of the proximomesial bases of the central projection and caudal process; an acumen that on average comprises about 45% of the rostrum length; and a carapace that, caudal to the cervical groove, is granulate both dorsally and laterally.

*Etymology.*—Despite his being an unrepentant vertebrate zoologist who has always “outcrayfished” me in the field, I take great pleasure in naming this new species for Alvin L. Braswell, Curator of Lower Vertebrates, NCSM, who has been a friend, colleague, and congenial field companion for many years. Suggested vernacular name: Waccamaw Crayfish.

#### Acknowledgments

My thanks go to those collectors who provided the specimens of this new crayfish, and particularly to David R. Lenat. I am grateful, too, for the reviews of the manuscript by Roger F. Thoma and Steve Busack, and especially for the always astute attentions of Joseph F. Fitzpatrick, Jr. Nancy Childs provided technical assistance in the preparation of the figure. I also express my sincerest gratitude to Alvin L. Braswell, John E. Cooper, Jr., Martha R. Cooper, Jesse Perry, and particularly to Don Howard, without whose unstinting assistance this paper would never have been realized. My greatest debt, which I cannot adequately express, remains to the late Horton H. Hobbs, Jr., mentor and friend, whose outstanding work on the members of the Pictus Group of *Procambarus* provided the framework for understanding the relationships of *P. braswelli*.

#### Literature Cited

- Cooper, J. E., & A. L. Braswell. 1995. Observations on North Carolina crayfishes (Decapoda: Cambaridae).—*Brimleyana* 22:87–132.
- Cooper, M. R., & J. E. Cooper. 1977a. A comment on crayfishes. Pp. 198–199 in J. E. Cooper, S. S. Robinson, & J. B. Funderburg, eds., *Endangered and threatened plants and animals of North Carolina*. North Carolina State Museum of Natural History, Raleigh, 444 pp.
- , & ———. 1977b. *Procambarus (Ortmannicus) lepidodactylus* Hobbs. Pp. 206–207 in J. E. Cooper, S. S. Robinson, & J. B. Funderburg, eds., *Endangered and threatened plants and animals of North Carolina*. North Carolina State Museum of Natural History, Raleigh, 444 pp.
- Fitzpatrick, J. F., Jr. 1983. How to know the freshwater crustacea. William C. Brown Company, Publishers, Dubuque, Iowa, 227 pp.
- Franz, R., & D. S. Lee. 1982. Distribution and evolution of Florida's troglitic crayfishes.—*Bulletin of the Florida State Museum, Biological Sciences* 28:53–78.
- Frey, D. G. 1951. The fishes of North Carolina's bay lakes and their intraspecific variations.—*Journal of the Elisha Mitchell Scientific Society* 67:1–44.
- Fuller, S. L. H. 1977. Freshwater and terrestrial mollusks. Pp. 143–194 in J. E. Cooper, S. S. Robinson, & J. B. Funderburg, eds., *Endangered and threatened plants and animals of North Carolina*. North Carolina State Museum of Natural History, Raleigh, 444 pp.
- Girard, C. 1852. A revision of the North American Astaci with observations on their habits and geographical distribution.—*Proceedings of the Academy of Natural Sciences of Philadelphia* 6: 87–91.
- Harlan, R. 1830. Description of a new species of the genus *Astacus*.—*Transactions of the American Philosophical Society* 3(15):464–465.
- Hobbs, H. H., Jr. 1940. Seven new crayfishes of the genus *Cambarus* from Florida, with notes on other species.—*Proceedings of the United States National Museum* 89:387–423.
- . 1947a. A key to the crayfishes of the Pictus Subgroup of the genus *Procambarus*, with the description of a new species from South Carolina.—*The Florida Entomologist* 30(3):25–31.
- . 1947b. Two new crayfishes of the genus *Procambarus* from Georgia, with notes on *Procambarus pubescens* (Faxon).—*Quarterly Journal of the Florida Academy of Sciences* 9:1–18.
- . 1958a. The evolutionary history of the Pictus Group of the crayfish genus *Procambarus* (Decapoda, Astacidae).—*Quarterly Journal of the Florida Academy of Sciences* 21:71–91.

- . 1958b. Two new crayfishes of the genus *Procambarus* from South Carolina.—*Journal of the Washington Academy of Sciences* 48(5):160–168.
- . 1958c. Two new crayfishes of the genus *Procambarus* from South Carolina and Georgia.—*Notulae Naturae* 307:1–12.
- . 1962. Notes on the affinities of the members of the Blandingii Section of the crayfish genus *Procambarus* (Decapoda, Astacidae).—*Tulane Studies in Zoology* 9(5):273–293.
- . 1968. Crustacea: Malacostraca. Pp. K1–K36 in F. K. Parrish, ed., *Keys to water quality indicative organisms (southeastern United States)*. Federal Water Pollution Control Administration, United States Department of the Interior, Washington, D. C., 36 pp.
- . 1972. Crayfishes (Astacidae) of North and Middle America. Biota of freshwater ecosystems identification manual no. 9. United States Environmental Protection Agency, Washington, D. C., 173 pp.
- . 1974. A checklist of the North and Middle American crayfishes (Decapoda: Astacidae and Cambaridae).—*Smithsonian Contributions to Zoology* 166:1–161.
- . 1989. An illustrated checklist of the American crayfishes (Decapoda: Astacidae, Cambaridae, and Parastacidae).—*Smithsonian Contributions to Zoology* 480:1–236.
- , & R. Franz. 1986. New troglobitic crayfish with comments on its relationship to epigean and other hypogean crayfishes of Florida.—*Journal of Crustacean Biology* 6:509–519.
- , & D. J. Peters. 1977. The entocytherid ostracods of North Carolina.—*Smithsonian Contributions to Zoology* 247:1–73.
- , H. H. Hobbs, III, & M. A. Daniel. 1977. A review of the troglobitic decapod crustaceans of the Americas.—*Smithsonian Contributions to Zoology* 244:1–183.
- Hubbs, C. L., & E. C. Raney. 1946. Endemic fish fauna of Lake Waccamaw, North Carolina.—*Miscellaneous Publications of the University of Michigan Museum of Zoology* 65:1–30.
- Johnson, R. I. 1984. A new mussel, *Lampsilis (Lampsilis) fullerkerati* (Bivalvia: Unionidae) from Lake Waccamaw, Columbus County, North Carolina, with a list of the other unionid species of the Waccamaw River system.—*Museum of Comparative Zoology Occasional Papers on Mollusks* 4:289–298.
- LeGrand, H. E., Jr. 1993. Natural Heritage Program list of the rare animal species of North Carolina. North Carolina Natural Heritage Program, Raleigh, 45 pp.
- , & S. P. Hall. 1995. Natural Heritage Program list of the rare animal species of North Carolina. North Carolina Natural Heritage Program, Raleigh, 67 pp.
- , & ———. 1997. Natural Heritage Program list of the rare animal species of North Carolina. North Carolina Natural Heritage Program, Raleigh, 82 pp.
- Menhinick, E. F. 1991. The freshwater fishes of North Carolina. North Carolina Wildlife Resources Commission, Raleigh, 227 pp.
- Porter, H. J., & K. J. Horn. 1984. Freshwater Mollusca of upper Waccamaw River, North and South Carolina.—*Journal of the Elisha Mitchell Scientific Society* 97:270.
- Rohde, F. C., R. G. Arndt, D. G. Lindquist, & J. F. Parnell. 1994. Freshwater fishes of the Carolinas, Virginia, Maryland, and Delaware. University of North Carolina Press, Chapel Hill, 222 pp.
- Shute, J. R., P. W. Shute, & D. G. Lindquist. 1981. Fishes of the Waccamaw River drainage.—*Brimleyana* 6:1–24.
- Teulings, R. P., & J. E. Cooper. 1977. Cluster areas. Pp. 409–433 in J. E. Cooper, S. S. Robinson, & J. B. Funderburg, eds., *Endangered and threatened plants and animals of North Carolina*. North Carolina State Museum of Natural History, Raleigh, 444 pp.
- Williams, A. B., L. G. Abele, D. L. Felder, H. H. Hobbs, Jr., R. B. Manning, P. A. McLaughlin, & I. Pérez Farfante. 1989. Common and scientific names of aquatic invertebrates from the United States and Canada: Decapod crustaceans. *American Fisheries Society Special Publication* 17, 77 pp.